

Hypoglycaemic Symptoms Reported by Children with Type 1 Diabetes Mellitus and by Their Parents

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To compare the hypoglycaemic symptoms reported by children with Type 1 diabetes and signs observed by and symptoms reported to their parents, 101 pairs, consisting of a child with diabetes and one of their parents, were asked to report the frequency with which they experienced, or witnessed, each of 31 symptoms during hypoglycaemia. The hypoglycaemic symptoms reported by the children and the reported symptoms and signs observed by their parents were classified, using multivariate statistical analyses, and compared. Close agreement was observed between the children and their respective parents' scores for frequencies of most symptoms/signs, as demonstrated by Spearman's rank correlations (median $\tau_s = 0.25$, $p < 0.02$). Principal Components Analysis of the symptoms/signs observed by the parents showed three factors: autonomic, neuroglycopenic, and behavioural disturbance. Analysis of the symptoms experienced by the children also identified three factors: behavioural disturbance, malaise and a third factor consisting of a combination of autonomic and neuroglycopenic symptoms. The parents could differentiate three separate groups of reported hypoglycaemic symptoms and signs (autonomic, neuroglycopenic, and behavioural disturbance) in their children. The children reported a similar group of behavioural symptoms but did not discriminate between autonomic and neuroglycopenic symptoms. These findings have important implications for the education of parents and children with Type 1 diabetes regarding the symptoms and signs of hypoglycaemia. © 1998 John Wiley & Sons, Ltd.

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Introduction

Hypoglycaemia is a common problem in the treatment of children with Type 1 diabetes¹ and children differ from adults in their profile of hypoglycaemia-related symptoms. Whereas the classification of symptoms of hypoglycaemia reported by adults with insulin-treated diabetes has been studied in detail using statistical techniques such as Principal Components Analysis (PCA)^{2–4} and by physiological methods,^{5,6} the symptoms of hypoglycaemia experienced by children with Type 1 diabetes have attracted less attention.

In a previous study from our centre, McCrimmon *et al.*⁷ recorded the hypoglycaemia-related symptoms and signs reported to and observed by the individual parents of 100 children with Type 1 diabetes and compared their responses with the symptoms reported by 43 of these children. The children and their parents showed close agreement concerning the relative frequency and

intensity of each symptom reported. Principal Components Analysis of the data showed that both the children and their parents were able to identify a group of symptoms related to behavioural disturbance, a feature of hypoglycaemia which was not so evident in adults treated with insulin. Moreover, both groups were unable to discriminate between autonomic and neuroglycopenic symptoms in contrast to adult subjects.^{2–4}

In McCrimmon's study,⁷ the children and their parents were questioned by the same interviewer in the same room, with the parent questioned first. A degree of unintended collusion between child and parent was therefore permitted, potentially influencing the given responses. In addition, the number of children interviewed was small, many potential subjects being excluded because they were too young to respond reliably and validly. Few very young children were included. In the present study we report a replication and extension of this research, with methodological improvements and innovations to improve the quality of the data. This study aimed to further our understanding of the nature of hypoglycaemic symptomatology in children with Type 1 diabetes, their parents' perceptions of the symptoms, and to work towards the development of valid symptom scales applicable to children.

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Patients and Methods

One hundred and one subject pairs, each consisting of a child with Type 1 diabetes and one of his/her parents, were recruited from the diabetic clinic at the Royal Hospital for Sick Children, Edinburgh. The children were aged 11.0 ± 2.7 (mean \pm SD), range 5–17 years. Their duration of diabetes was 4.7 ± 2.9 years, their mean HbA_{1c} $8.6 \pm 1.4\%$ over the preceding year (local non-diabetic adult reference range for HbA_{1c} 4.0–5.8%) and their mean daily insulin dose 0.92 ± 0.3 U kg⁻¹. All of the children had experienced hypoglycaemia. Five of the parents interviewed also had Type 1 diabetes, most of whom had previous subjective experience of hypoglycaemia. At the time of the interview, no child showed overt signs of prevailing hypoglycaemia, although blood glucose was not measured.

In order to improve the validity of the responses compared with those obtained by McCrimmon *et al.*,⁷ the parents and their children were interviewed separately in adjacent rooms by two different interviewers so that no collaboration was possible. In addition, the names of many of the symptoms of hypoglycaemia were presented with alternative wordings, so widening the age range and increasing the number of children eligible for inclusion in the study. These wordings were offered whenever the subject did not appear to understand the symptom as originally presented to ensure consistency. Alternative wordings were available for 21 of the 31 symptoms and are listed in Appendices 1 and 2. These wordings were particularly useful when questioning the younger children, aged 5 to 10 years. Despite these modifications, children under 5 years old were considered to be too young to co-operate and give valid responses. They were therefore excluded from the study.

The parents were shown a list of 31 possible symptoms/signs of hypoglycaemia and were asked to identify which ones they believed to occur in their child and rate these according to the frequency with which they were reported or witnessed during hypoglycaemia. The children were also asked to identify which of the same 31 symptoms they experienced during hypoglycaemia and to rate these by frequency of occurrence. The subjects were asked to score the occurrence of each symptom according to the following 5 point scale: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always. The symptom list incorporated autonomic, neuroglycopenic, malaise, and behavioural symptoms, as classified previously,^{2–4} as well as three 'dummy' symptoms unrelated to hypoglycaemia (cough, hic-coughs, itchiness) which were included to detect any spurious answers or 'yea-saying' response biases (Table 1).

Statistical Analysis

The association between each child's and his/her parent's rating of the frequency of individual symptoms/signs was examined using Spearman's rank correlation.

The symptom ratings were then examined using Principal Components Analysis (PCA).^{2,8} PCA was used to reveal the latent structure of the symptom data, beginning with a correlation matrix where the subjects' scores for every symptom are correlated with those for every other symptom. Subgroups of symptoms that intercorrelate relatively highly are revealed, suggesting certain groupings with a possible common underlying cause. Thus a large number of variables (the individual symptoms) may be reduced to a few underlying components (the symptom groups). In the present study, the number of components was estimated using the Scree test.⁸ The content of the components thus identified is determined by a method which assures that as much of the symptom covariance as possible is contained in the first component, the next most in the second, and so on. However, this rarely corresponds with the real structure of the data, and so a method of rotation is applied. Rotation of the components identifies a series of more distinct groupings among the variables. During an 'orthogonal' rotation, all axes are held perpendicular to each other, but an oblique rotation allows the axes to rotate through different angles and may improve the clarity of the components. The oblique solutions are considered in these analyses.

A 'loading' of a variable on a component is the correlation of a given variable with the underlying component and may take a value from -1 to $+1$. It is common practice to consider loadings of $\pm >0.3$ as significant, but the value taken depends upon sample size and the number of components involved. In these analyses, a symptom loading of ≥ 0.4 on one factor and ≤ 0.2 on all other factors was the criterion for item retention, thus achieving clear and distinct factors. In the following analyses, the usual convention of referring to components as 'factors' is adopted though, strictly speaking, there are some differences between component and factor analysis.

Results

Dummy symptoms were very rarely endorsed and were excluded from analyses. For each of the 28 remaining symptoms, the frequency of supra-baseline responses and the mean score from the parents' ratings of their children and from the children's own ratings are shown in Table 1.

The reported symptoms which received the highest mean scores from the parents were: feeling awful, irritable, hungry, feeling tired, and feeling weak; the symptoms from the children were: trembling, feeling weak, hungry, dizziness, feeling awful, and feeling tired. The large, significant correlation between the mean scores for each symptom given by the parents and the children ($r = 0.8$, $p = 0.0001$) is shown in Figure 1.

The more subjective symptoms of hypoglycaemia experienced by the children, such as trembling, pounding heart and dizziness (see Appendix 2) received higher

Table 1. Hypoglycaemia symptom scores reported by children with Type 1 diabetes and their parents

Number	Symptom	Parents		Children		τ_s^a
		Frequency (%)	Mean score	Frequency (%)	Mean score	
1	Tearful	73	1.6	47	1.0	0.40 ^d
2	Headache	73	1.9	65	1.5	0.33 ^d
3	Irritable	85	2.4	65	1.8	0.16
4	Unco-ordinated	62	1.4	56	1.5	0.18
5	Naughty	47	1.1	31	0.6	0.23 ^b
6	Weak	79	2.1	83	2.6	0.21 ^b
7	Aggressive	75	1.9	62	1.5	0.26 ^c
8	Trembling	79	2.0	88	2.7	0.25 ^b
9	Sleepiness	63	1.5	69	1.9	0.27 ^c
10	Nightmares	33	0.6	19	0.4	0.33 ^d
11	Sweating	76	2.0	73	1.8	0.28 ^c
12	Slurred speech	53	0.9	45	0.9	0.28 ^c
13	Blurred vision	52	0.9	55	1.2	0.30 ^c
14	Tummy pain	67	1.5	41	0.8	0.36 ^d
15	Feeling sick	63	1.3	53	1.2	0.32 ^c
16	Hungry	74	2.3	84	2.5	0.19
17	Yawning	48	1.0	45	1.0	0.20 ^b
18	Odd behaviour	65	1.4	50	1.1	0.22 ^b
19	Warmness	57	1.4	68	1.7	0.13
20	Restless	61	1.5	57	1.4	0.21 ^b
21	Daydreaming	70	1.5	48	1.1	0.14
22	Argumentative	64	1.7	50	1.2	0.21 ^b
23	Pounding heart	21	0.3	44	0.9	0.02
24	Confused	75	1.7	70	1.7	0.41 ^d
25	Tingling lips	20	0.3	24	0.5	-0.01
26	Dizziness	66	1.5	87	2.3	0.28 ^c
27	Tired	83	2.1	76	2.2	0.26 ^c
28	Feeling awful	92	2.7	79	2.3	0.20

^a p of z (corrected for ties). ^b $p < 0.05$, ^c $p < 0.01$, ^d $p < 0.001$.

mean scores from the children than the parents (paired two-tail t -test, $p = 0.0001$). The more objective features of hypoglycaemia, such as being tearful, irritable, naughty, and complaining of abdominal pain, received higher mean scores from the parents than the children (paired two-tail t -test, $p < 0.003$).

The correlation of frequency ratings for most of the individual symptoms recorded by each parent and their child was highly significant, using Spearman's rank correlation [median (range) for all 28 symptoms, corrected for ties, $\tau_s = 0.25$ (-0.01–0.4), $p < 0.02$ (0.0001–0.91)]. This indicated that, overall, there was a relationship between the children's and their parent's reports of the frequency of each symptom during hypoglycaemia (Table 1).

Factor Analysis of Parents' Reported Symptoms

The parents' scores for the 28 reported symptoms/signs of hypoglycaemia were subjected to PCA, followed by

oblique rotation, and the results of this analysis are shown in Table 2. Four factors were extracted. Factor 1 represented neuroglycopenic symptoms, factor 2 consisted largely of behavioural symptoms and factor 3 contained autonomic symptoms. Factor 4 comprised only two symptoms (Table 3).

In order to clarify the factors, the data were re-examined using pre-determined criteria, as described above: only those items loading ≥ 0.4 on any one of the first three factors and ≤ 0.2 on all the other factors were selected. This eliminated the two symptoms in factor 4 and reduced the total number of symptoms to 17. When the scores from these 17 symptoms were subjected to PCA followed by rotation, the oblique solution revealed three clear factors, representing the same symptom groups as the first three factors given above (Tables 2 and 3).

In order to test the three factor structure of the Edinburgh Hypoglycaemia Scale (EHS)⁴ in this sample, a PCA was performed using the parents' responses to

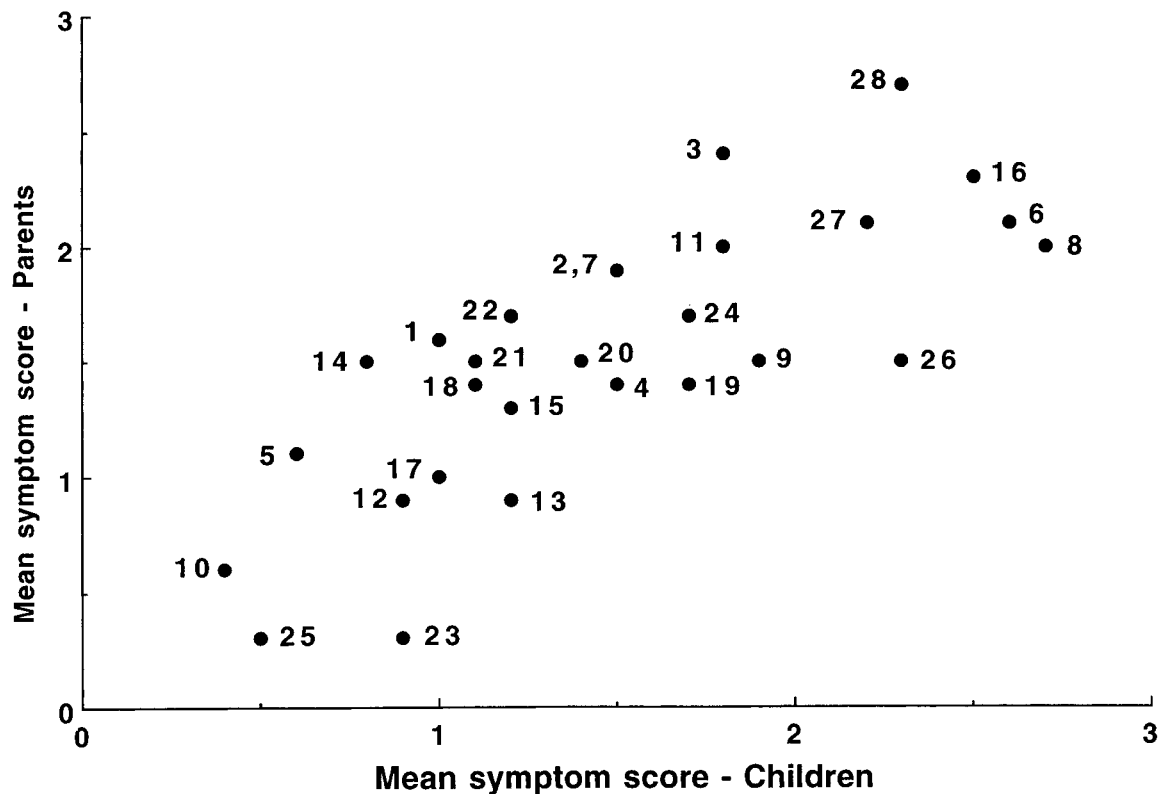


Figure 1. Mean score for each hypoglycaemic symptom reported by parents and children. See Table 1 for key to symptom numbers

only the 11 symptoms in the EHS. Three factors were stipulated and the obliquely rotated solution approximated the EHS. Factor 1 represented neuroglycopenic symptoms; factor 2 consisted of autonomic symptoms and the symptoms in factor 3 were feeling sick and headache, representing general malaise (Table 3).

PCA of the initial 28 symptoms showed the first unrotated principal component (FPC) had moderate-to-high positive loadings for all symptoms (mean 0.48, range 0.23–0.66) and accounted for 24.5 % of the variance. This confirms the presence of a general hypoglycaemic factor (Table 2). When the analysis was reduced to 17, and subsequently to 11, symptoms, the percentage of the variance accounted for by the FPC increased to 30 % and 33 %, respectively.

Factor Analysis of Childrens' Reported Symptoms

The childrens' responses to the 28 symptoms were subjected to PCA, three factors were extracted and the obliquely-rotated solution is presented in Table 2. Factor 1 represented a combination of autonomic and neuroglycopenic symptoms. Factor 2 consisted of behavioural disorder symptoms and factor 3 contained a mixture of symptoms representing general malaise and tiredness (Table 3).

The analysis was then reduced and clarified, as before, taking only those symptoms with loadings of ≥ 0.4 on

one factor and ≤ 0.2 on both other factors. This left 16 symptoms to be examined further. PCA followed by rotation again gave the following oblique, three factor solution (Table 2): factor 1 contained behavioural disorder symptoms; factor 2 comprised symptoms of general malaise and tiredness and factor 3 had a mixture of autonomic and neuroglycopenic symptoms (Table 3).

When the same analysis was restricted to the 11 symptoms in the Edinburgh Hypoglycaemia Scale,⁴ a three factor solution was obtained. Factor 1 contained a mixture of autonomic and neuroglycopenic symptoms; factor 2 comprised symptoms of general malaise and tiredness and factor 3 consisted of hunger and odd behaviour (Table 3).

PCA of the initial 28 symptoms again showed the FPC extracted had moderate-to-high positive loadings for most symptoms (mean 0.41, range 0.13–0.75) and accounted for 19 % of the variance (Table 2). This again confirms the presence of a general hypoglycaemic factor, but suggests that there is more error variance in the childrens' reports. When the analysis was reduced to 16 and then to 11 symptoms, the percentage of the variance accounted for by the FPC increased to 22 % and to 24 %, respectively.

The 17 symptoms which were identified as markers of the three factors as determined by parents of diabetic children are shown in Appendix 1. We have called this the Edinburgh Childrens' Hypoglycaemia Scale – Parent or ECHS-P). The 16 symptoms which were useful markers

Table 2. Principal components analysis of hypoglycaemia symptom scores reported by children with Type 1 diabetes and their parents

Symptom	Parents							Children						
	FPC	28 symptom analysis Factors			17 symptom analysis Factors			FPC	28 symptom analysis Factors			16 symptom analysis Factors		
		1	2	3	1	2	3		1	2	3	1	2	3
Tearful	42	09	39	10	16	44	01	39	21	−12	34			
Headache	41	09	57	−11	11	53	−01	26	−01	−01	38	06	52	−23
Irritable	55	01	82	11	−01	84	02	48	−10	84	01	89	−01	−14
Unco-ordinated	61	72	−02	12	75	03	−04	46	62	22	−22	24	−13	59
Naughty	36	−01	72	−17	01	72	−09	29	−34	60	21			
Weak	60	55	−14	42				41	65	17	−21	02	−01	72
Aggressive	56	−07	84	09	−02	86	08	60	11	75	03	84	01	01
Trembling	38	01	−15	74	07	−16	64	25	75	01	−45	01	−26	77
Sleepiness	66	73	08	−06	74	14	−06	52	28	−17	60	−28	76	13
Nightmares	28	19	−02	−12				16	−11	06	28			
Sweating	58	22	−06	55	26	−10	67	49	45	−03	23	−21	45	42
Slurred speech	62	77	−03	−04	85	−01	−01	51	48	−14	35			
Blurred vision	45	30	07	12				40	43	−01	11	−15	15	45
Tummy pain	23	−18	33	−03				13	−17	−08	44	15	42	−51
Feeling sick	44	33	36	−12				44	−13	01	75	−05	79	−32
Hungry	24	09	−20	31				15	07	07	07			
Yawning	48	53	04	−24				47	12	08	46	01	50	01
Odd behaviour	66	31	23	48				43	15	59	−11	51	−15	24
Warmness	44	−23	02	62	−18	02	82	37	00	21	32			
Restless	55	−06	21	63	−04	16	71	39	14	21	20			
Daydreaming	56	48	01	07	54	−05	25	40	22	37	01			
Argumentative	51	−11	86	14	−11	89	05	33	−08	68	−08	84	−13	−18
Pounding heart	41	−03	17	47	−01	15	45	34	22	22	04			
Confused	63	62	17	14	71	14	02	75	45	29	31			
Tingling lips	34	−08	02	27				29	47	−31	20			
Dizziness	35	20	05	23				50	24	06	40			
Tired	61	76	−06	04	73	−05	06	64	22	03	65	−07	79	04
Feeling awful	52	33	01	47				57	51	06	21	10	44	26

FPC, first principal component. 'Factors' are rotated oblique solutions.

Decimal points are omitted from factor loadings. Loadings greater than 40 are shown in bold type.

of the three factors as determined by the reports of the children are shown in Appendix 2. We have called this the Edinburgh Childrens' Hypoglycaemia Scale – Child. Together, these two scales represent 24 of the 28 hypoglycaemic symptoms used in the original questionnaire.

Discussion

The present study extends our studies of the classification of the symptoms of hypoglycaemia.^{2–4,7} There was a significant correlation between the mean scores for each symptom of hypoglycaemia reported by the children with Type 1 diabetes and their parents, demonstrating

that parents and children with Type 1 diabetes have a similar profile of hypoglycaemic symptoms.

It should be noted that the symptoms of hypoglycaemia as described by the affected individuals (the children) and those reported to and by the observers (the parents) may not be identical. The children are describing a subjective reality of hypoglycaemia, while their parents can only describe their observations of objective signs which they attribute to hypoglycaemia and report on the subjective sensations that their children have described to them, which they also attribute to hypoglycaemia.

This was a retrospective study. There was no definitive biochemical confirmation of hypoglycaemia at the time of symptoms. Nevertheless, the children and/or their

Table 3. Principal Components Analysis of hypoglycaemia symptom scores reported by children with Type 1 diabetes and their parents

Parents

28 symptom analysis: 4 factors

17 symptom analysis: 3 factors – factors 1, 2 and 3 only

Factor 1 Neuroglycopenic symptoms	Factor 2 Behavioural symptoms	Factor 3 Autonomic symptoms	Factor 4
(a) unco-ordinated (b) sleepiness (c) slurred speech (d) daydreaming (e) confused (f) tired	(a) tearful (b) headache (c) irritable (d) naughty (e) aggressive (f) argumentative	(a) trembling (b) sweating (c) warmth (d) restless (e) pounding heart	(a) nightmares (b) tingling lips
<i>Edinburgh Hypoglycaemia Scale analysis: 3 factors</i>			
Factor 1 Neuroglycopenic symptoms	Factor 2 Autonomic symptoms	Factor 3 Malaise	
(1a,1b,1c,1e) plus odd behaviour	(3a,3b,3d) plus feeling hungry	feeling sick headache	

Children

28 symptom analysis: 3 factors

Factor 1 Autonomic/neuroglycopenic symptoms	Factor 2 Behavioural symptoms	Factor 3 Malaise
(a) unco-ordinated (b) weak (c) trembling (d) sweating (e) slurred speech (f) blurred vision (g) confused (h) tingling lips	(a) irritable (b) naughty (c) aggressive (d) odd behaviour (e) argumentative	(a) headache (b) sleepiness (c) tummy pain (d) feeling sick (e) yawning (f) feeling tired
<i>16 symptom analysis: 3 factors</i>		
Factor 1 Behavioural symptoms	Factor 2 Malaise	Factor 3 Autonomic/neuroglycopenic symptoms
(2a,2c,2d,2e)	(3a,3b,3d,3e,3f) plus feeling awful	(1a,1b,1c,1f)
<i>Edinburgh Hypoglycaemia Scale analysis: 3 factors</i>		
Factor 1 Autonomic/neuroglycopenic symptoms	Factor 2 Malaise	Factor 3
(1a,1c,1d) plus pounding heart	(3a,3b,3d)	hunger odd behaviour

parents perform regular capillary blood glucose tests and families are taught to check blood glucose whenever hypoglycaemia is suspected, so false positive responses, while not excluded, were unlikely.

A highly significant correlation was observed between the frequency ratings for the individual symptoms as reported by each parent and their own child, in agreement with the earlier study.⁷ Thus, although individuals each have an idiosyncratic symptomatic response to hypoglycaemia,⁹ the parent of a diabetic child appears to be an

accurate observer of the manner in which their own child is affected by hypoglycaemia.

Statistical analysis of the parents' symptom ratings, using Principal Components Analysis, showed that they distinguish between hypoglycaemic symptoms in their children that are generated through activation of the autonomic nervous system and those that are 'neuroglycopenic'. Autonomic and neuroglycopenic symptoms emerged as two separate factors in the analyses of all three sets of symptom data. These findings contrast with

the study by McCrimmon *et al.*,⁷ in which parents appeared to be unable to make this discrimination. It is possible that the alternative wordings given for many of the symptoms in the revised questionnaire improved the comprehension of some of the parents, as well as the younger children, in answering the questions.

However, in agreement with the findings of McCrimmon *et al.*,⁷ the children were unable to distinguish between autonomic and neuroglycopenic symptoms. In PCA of their symptom ratings, from all three sets of symptom data, these two groups of symptoms co-segregated in a single factor. Adults with insulin-treated diabetes are able to differentiate between autonomic and neuroglycopenic symptoms, reporting them as two separate factors,²⁻⁴ yet children are unable to make this distinction. It may be that autonomic and neuroglycopenic symptoms are generated at similar glycaemic thresholds in children with Type 1 diabetes such that they are reported as one cluster of symptoms. Alternatively, children may be unable to give an accurate report of the autonomic symptoms that they experience.

A coherent group of hypoglycaemic symptoms/signs related to behavioural change was reported by parents and children in the present and previous studies.⁷ In the present study, these symptoms clustered together as a distinct factor in the analyses of the 28 and 17 symptom sets of the parents' responses and the 28 and 16 symptom set analyses of the childrens' responses. The Edinburgh Hypoglycaemia Scale (EHS),⁴ derived from studies of adult patients with insulin-treated diabetes, does not include any symptoms relating to behavioural disturbance (other than 'odd behaviour'), so this behavioural factor was artefactually absent from the PCA restricted to the 11 symptoms of this scale.

It may be that symptoms of behavioural disturbance as a marker for hypoglycaemia are peculiar to children. Alternatively, behavioural aspects of adult hypoglycaemic responses may have been under-represented in previous questionnaire-based studies. Behavioural changes are known to occur in both adults and children,¹⁰ but in adults, these changes are usually not evident until neuroglycopenia is profound.¹¹ Parents and other adult carers, such as schoolteachers, childminders, and activity group leaders, have a prominent role in the management of diabetes in children, particularly in the early detection and treatment of hypoglycaemia. Behavioural changes associated with hypoglycaemia may therefore be more readily observed and interpreted in children.

The signs and symptoms of hypoglycaemia for individual subjects with Type 1 diabetes vary with age. In the same way that children demonstrate a group of behavioural symptoms, elderly patients with insulin-treated diabetes appear to have a different symptom profile from younger adults with Type 1 diabetes. In a preliminary study by Jaap and colleagues¹² of hypoglycaemic symptoms reported by elderly insulin-treated diabetic patients, the prominent symptoms reported were unsteadiness, lightheadedness and confusion, contrasting

with children and younger adults.^{2-4,7} Both the elderly and children may be particularly vulnerable to hypoglycaemia as they may have difficulty with the identification of hypoglycaemia and be unable to initiate self-treatment. It is important therefore that the carers of children and of elderly people with Type 1 diabetes are able to recognize the relevant symptoms for the respective age group so that the serious potential risks of hypoglycaemia are avoided.

The questionnaires used in this study have been adapted to produce two hypoglycaemia symptom scales which include only those key symptoms which were found to be useful in discriminating the different symptom groups. We have called these the Edinburgh Childrens' Hypoglycaemia Scale-Parent and Edinburgh Childrens' Hypoglycaemia Scale-Child. It must be appreciated, however, that these symptom scales have been derived from questionnaire studies relating to hypoglycaemia as it occurs in everyday life and that experimentally induced hypoglycaemia may generate a different symptom profile. Also, the nature and intensity of the perception of hypoglycaemic symptoms may vary depending on factors such as the time of occurrence, posture, glycaemic control, recent hypoglycaemia and relationship to other activities, e.g. exercise, sleep, environmental distractions. With these reservations, these symptom scales should be a valuable tool in future research in this area.

Although hunger was among the highest scoring symptoms from both the parents and the children, it appears to be a non-specific symptom with loadings spread evenly across the three factors in both the parents' and the childrens' analyses. We have not included hunger in the symptom scales, which are based on the placing of symptoms into groups.

In conclusion, this study has demonstrated that parents are an accurate and reliable source of information regarding the symptoms and signs of hypoglycaemia in their children with Type 1 diabetes, showing significant correlations in both overall mean symptom scores given by parents and children and in individual symptom reporting within each parent and child pair. Parents are able to differentiate between autonomic and neuroglycopenic symptoms whereas children with Type 1 diabetes are unable to make this discrimination. Finally, behavioural symptoms are clearly a valuable index of hypoglycaemia in younger age groups and must be included in the initial education of all parents and adult carers. Further studies are required to elucidate the exact nature of the hypoglycaemia-induced behavioural changes of both children and adults, and such studies would require the inclusion of a wider range and appropriate selection of symptoms for different age groups.

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APPENDIX 1

Edinburgh Childrens' Hypoglycaemia Scale – Parent (ECHS – P)

	Alternative wording
tearful	<i>crying</i>
headache	<i>sore head</i>
irritable	<i>bad tempered</i>
uncoordinated	<i>clumsy</i>
naughty	
aggressive	<i>getting angry</i>
trembling	<i>shaking</i>
sleepiness	<i>falling asleep</i>
sweating	
slurred speech	<i>difficulty speaking</i>
warmness	<i>feeling warm</i>
restless	<i>fidgety</i>
daydreaming	<i>not paying attention</i>
argumentative	<i>picking a fight</i>
pounding heart	<i>'thumping' in chest</i>
confused	<i>difficulty thinking clearly</i>
tired	<i>'sluggish'</i>

The following symptoms were included in the original questionnaire: nightmares (*bad dreams*), hungry, tingling lips, dizziness.

APPENDIX 2

Edinburgh Childrens' Hypoglycaemia Scale – Child (ECHS-C)

	Alternative wording	Symptom type
headache	<i>sore head</i>	S
irritable	<i>bad tempered</i>	O
unco-ordinated	<i>clumsy</i>	O
weak	<i>'floppy'</i>	S
aggressive	<i>getting angry</i>	O
trembling	<i>shaking</i>	S
sleepiness	<i>falling asleep</i>	O/S
sweating		S
blurred vision	<i>hazy sight</i>	S
tummy pain	<i>sore tummy</i>	S
feeling sick		S
yawning		O
odd behaviour	<i>acting strangely</i>	O
argumentative	<i>picking a fight</i>	O
tired	<i>'sluggish'</i>	O/S
feeling awful	<i>'yukky'</i>	S

Principal type of symptom reported by children: S = subjective, O = objective.